   

SOLUM

insight from the ground up

2012-12-04

Fluid Fertilizer Foundation

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About Us

Solum is an agricultural technology company.

Solum develops advanced measurement systems and software solutions for commercial agriculture.

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1. **Introduction to soil measurements: Why, How, and what Quality?**

2. Field-moist processing for potassium

3. In-season measurements for nitrogen management

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What is a Soil Test?

- Soil tests estimate **probable** nutrient sufficiency and response to fertilization
- Often only a small fraction a nutrient is available at any given time.
- We are trying to estimate from a tiny sample, in a few minutes, an amount **proportional to what will be available** during an entire season

IT'S A MIRACLE IT WORKS AT ALL!

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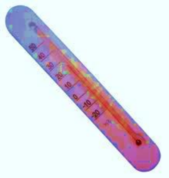
Adapted from A. Mallarino's 2012 presentation on K-tests

Typical Soil Test Processing

Homogenize
- Log sample information
- Dry for 12-24 hours
- Grind

Prepare
- Measure soil for each test
- Add extracts
- Shake
- Filter

Measure
- Samples analyzed by ICP and FIA



Drying ***Grinding*** ***Scooping*** ***Extraction Methodology*** ***Measurement Instrumentation***

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And that is only half the story…

Soil-test results need to be calibrated with crop response to fertilization

- How much nutrient is needed to optimize yield response or economic response in the deficient range
- Soil tests predict nutrient sufficiency and crop response, not yield levels

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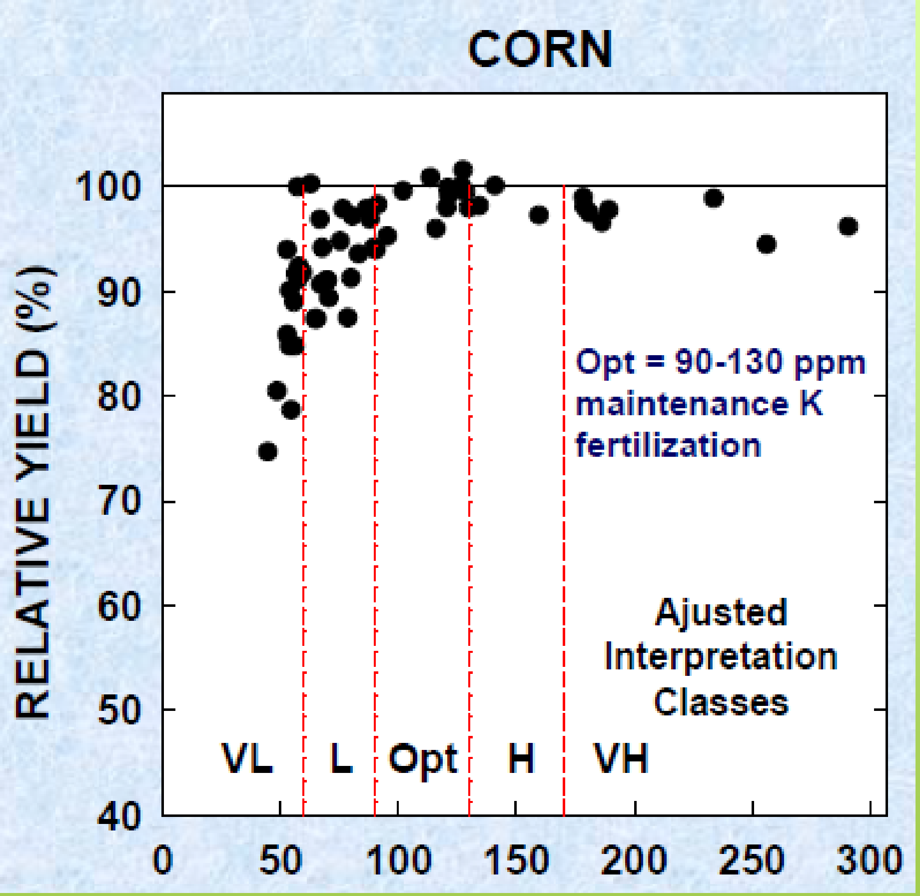
Adapted from A. Mallarino's 2012 presentation on K-tests

End result: yield versus soil test



Soil test Potassium (ppm)

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Adapted from A. Mallarino's 2012 presentation on K-tests

Why does it matter? A lot of $$ at stake!

Mehlich-III P [ppm]	ISU Fertility Class (2002)	P2O5 Rate [lbs/acre]	$/acre/ppm Error (Fertilizer)	$/acre/ppm Error (Yield, ISU)*	$/acre/ppm Error (Yield, Grower Data)**
0-15 ppm	Very Low (VL)	100	$0.59	$17.01	$17.63
16-25 ppm	Low (L)	75	$0.70	$7.10	$13.90
26-35 ppm	Optimum (O)	55	$1.93	$0.01	$10.16
36-45 ppm	High (H)	0	NA	NA	NA
above 45 ppm	Very High (VH)	0	NA	NA	NA

Soil Test K [ppm] (moist)	ISU Fertility Class (1988)	K2O Rate [lbs/acre]	$/acre/ppm Error (Fertilizer)	$/acre/ppm Error (Yield, ISU)*
0-35 ppm	Very Low (VL)	130	$0.34	$5.30
36-58 ppm	Low (L)	90	$0.23	$3.08
67-100 ppm	Optimum (O)	45	$0.42	$0.28
101-150 ppm	High (H)	0	NA	NA
above 150 ppm	Very High (VH)	0	NA	NA

NO3 [ppm]	Fertility Class	N Rate [lbs/acre	$/acre/ppm Error (Yield, Magdoff 1984)*
0-5 ppm	NA	NA	**$34.17**
5-10 ppm	NA	NA	**$22.92**
10-15 ppm	NA	NA	**$13.85**
15-20 ppm	NA	NA	**$6.95**
above 20 pm	NA	NA	

*Assumes 250 bu/ac corn, $6.50/bu

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And growers know that it matters!

Adoption for $1m+ farmers	
Precision Guidance	78%
Yield Monitor	80%
GPS Soil Sampling	56%
Variable Rate	
P, K, Lime (pH)	46-52%
Seed	25%
Herbicides	16%
Nitrogen	15%

Market Attributes

- 60m acres use grid-sampling in the US today
- 26% growth per year (Purdue survey)

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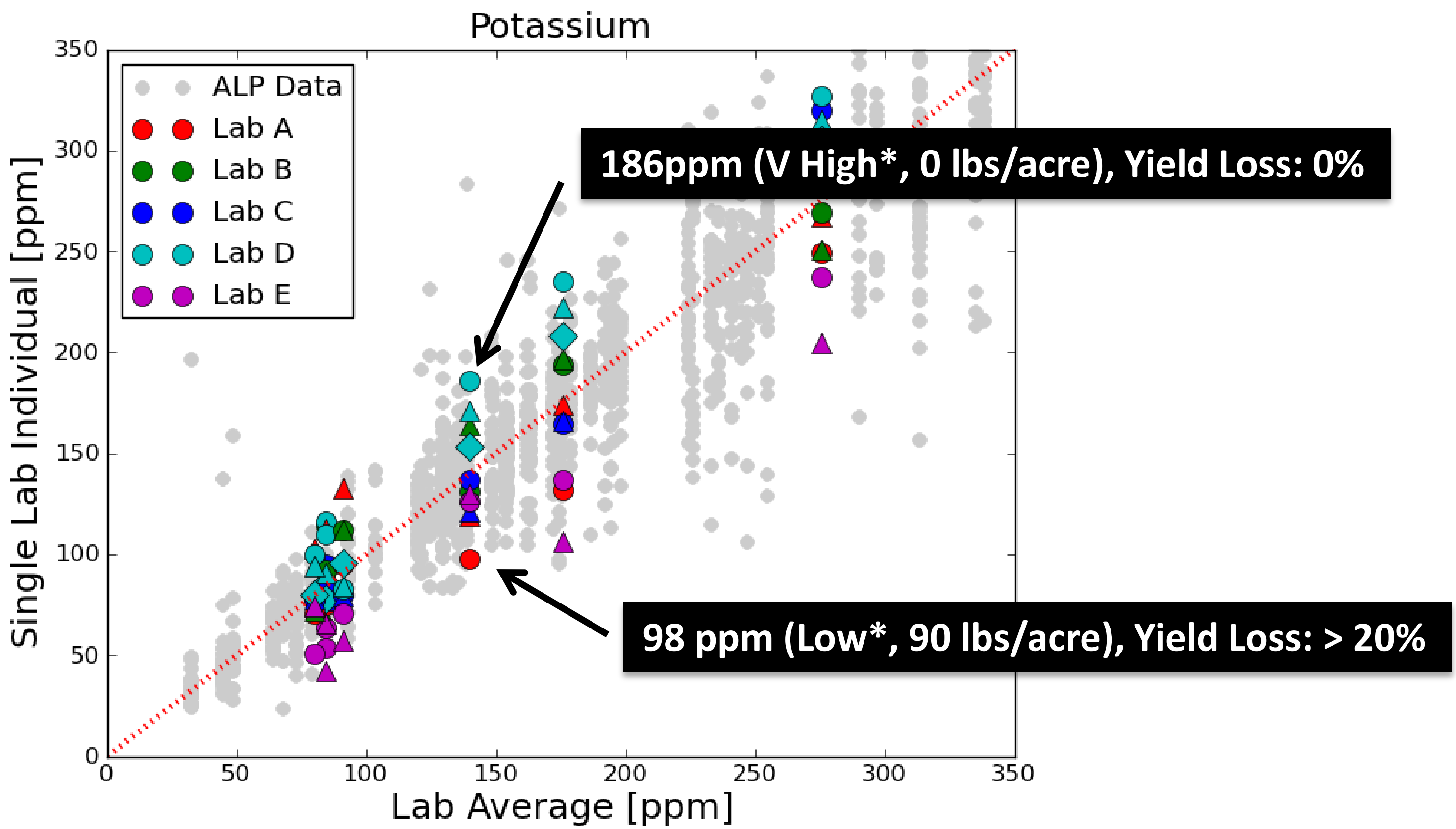
2009 Precision Agricultural Services: Dealership Survey Results. Purdue, 2009

How good is the data we are using?



*Fertility classes taken from ISU PM1688 (General Guide for Crop Nutrients Recommendations)

BACKGROUND: ALP program published results, 2011. Potassium, Mehlich III. SOLUM INTERLAB COMPARISONS, FALL 2011

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1. Intro to soil measurements: Why, How, and what Quality?

2. **Field-moist processing for potassium**

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Lab measurements: where does the error come from?

Homogenize

- Log sample information
- Dry for 12-24 hours
- Grind

Prepare

- Measure soil for each test
- Add extracts
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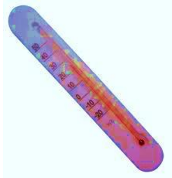
Measure

- Samples analyzed by ICP and FIA



Drying *Grinding* *Scooping* *Extraction Methodology* *Measurement Instrumentation*

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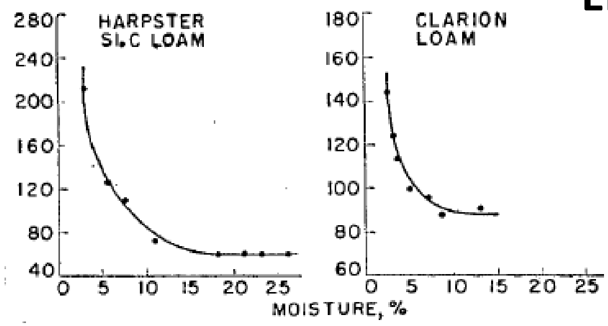
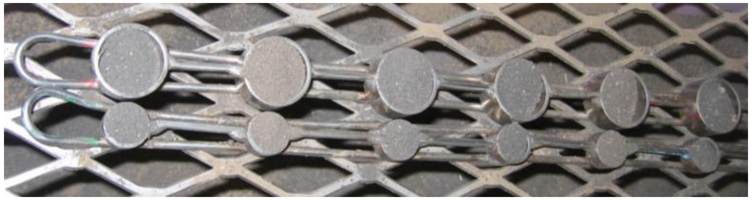
Another approach to sample analysis



Eliminate the processes that add error!



Field Moist Processing

Weigh

Fix the processes that cause error, automate it to make it commercial-scale.

Measurement Instrumentation

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Leubs et al, 1956.

Why field-moist processing?

- Drying of soil samples changes soil-test K results
- This isn't a problem **if** measured K is still a good index of K availability and response
- 1960s research showed that testing of field-moist samples was more reliable than of dried samples
- So, original Iowa State calibrations were for ammonium-acetate K test on moist samples

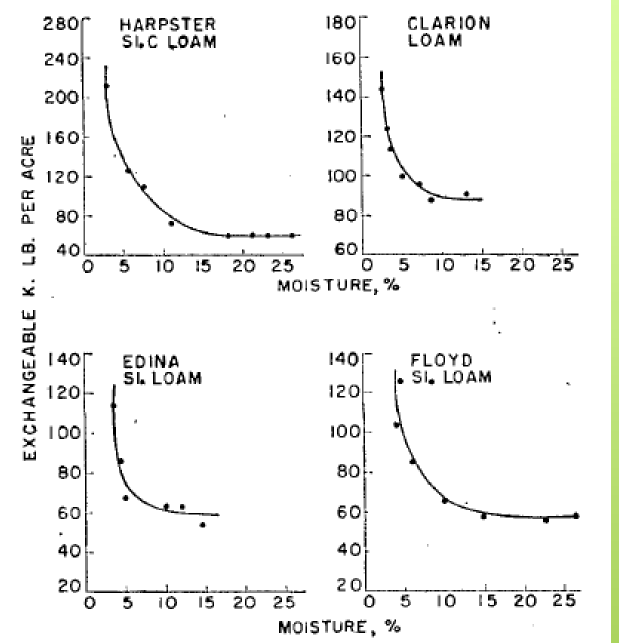

FIG. 3.—Relation of exchangeable K to moisture content at different stages of drying.

Leubs et al, 1956.

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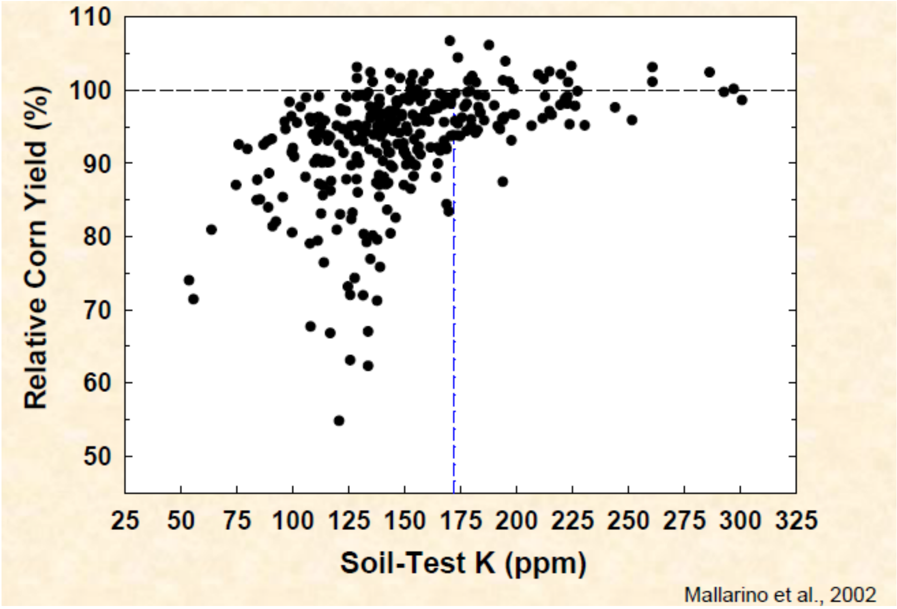
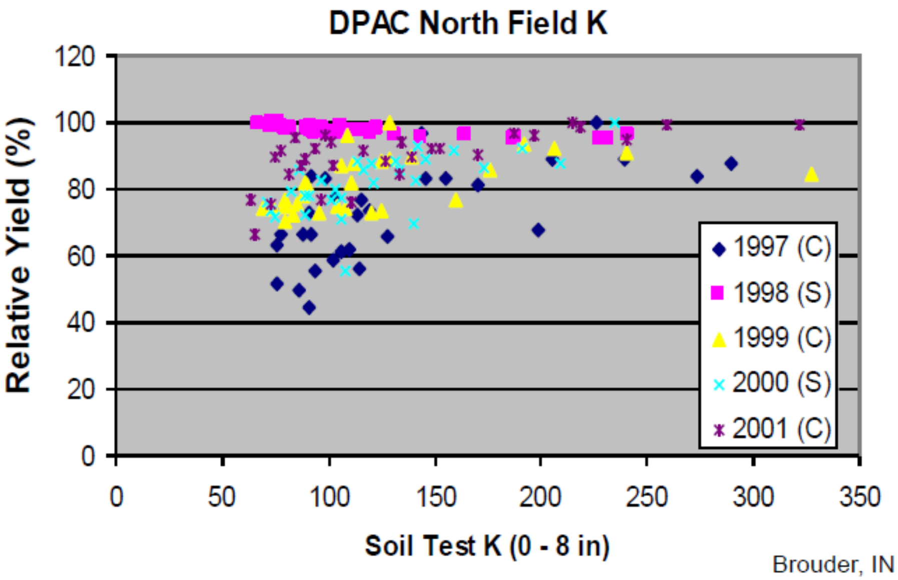
Poor correlation of dried/ground results to yield…





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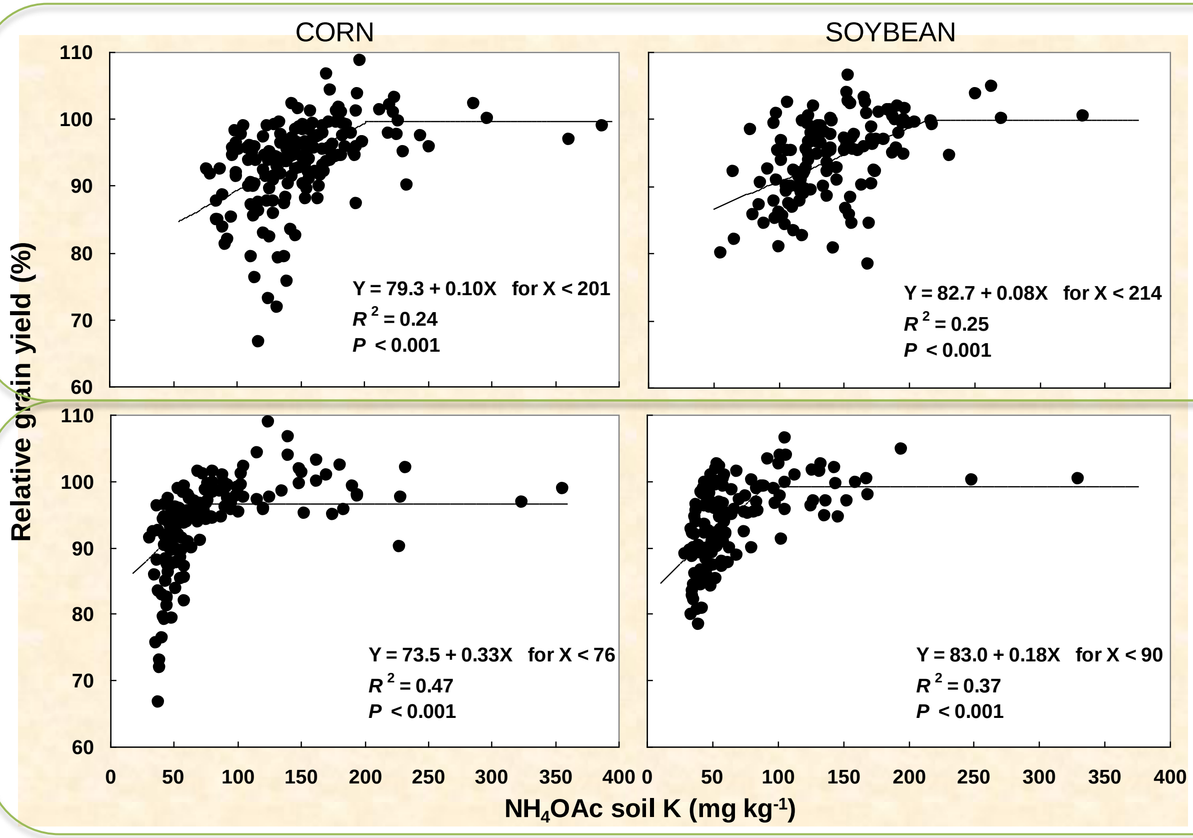
Field moist test is better predictor of crop response!

Relationship between RY and STK with LP model



Dried/ground processing decreases ability to predict crop sufficiency

Field moist processing has **2x better predictive power**

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Barbagelata and Mallarino, 2005.

Commercial-available field-moist testing

As of 2012: field moist processing is back as an official NCR-13 method!

Solum opened the doors of our measurement laboratory (using field processing) in Sept, 2012, offering a full range of soil tests.

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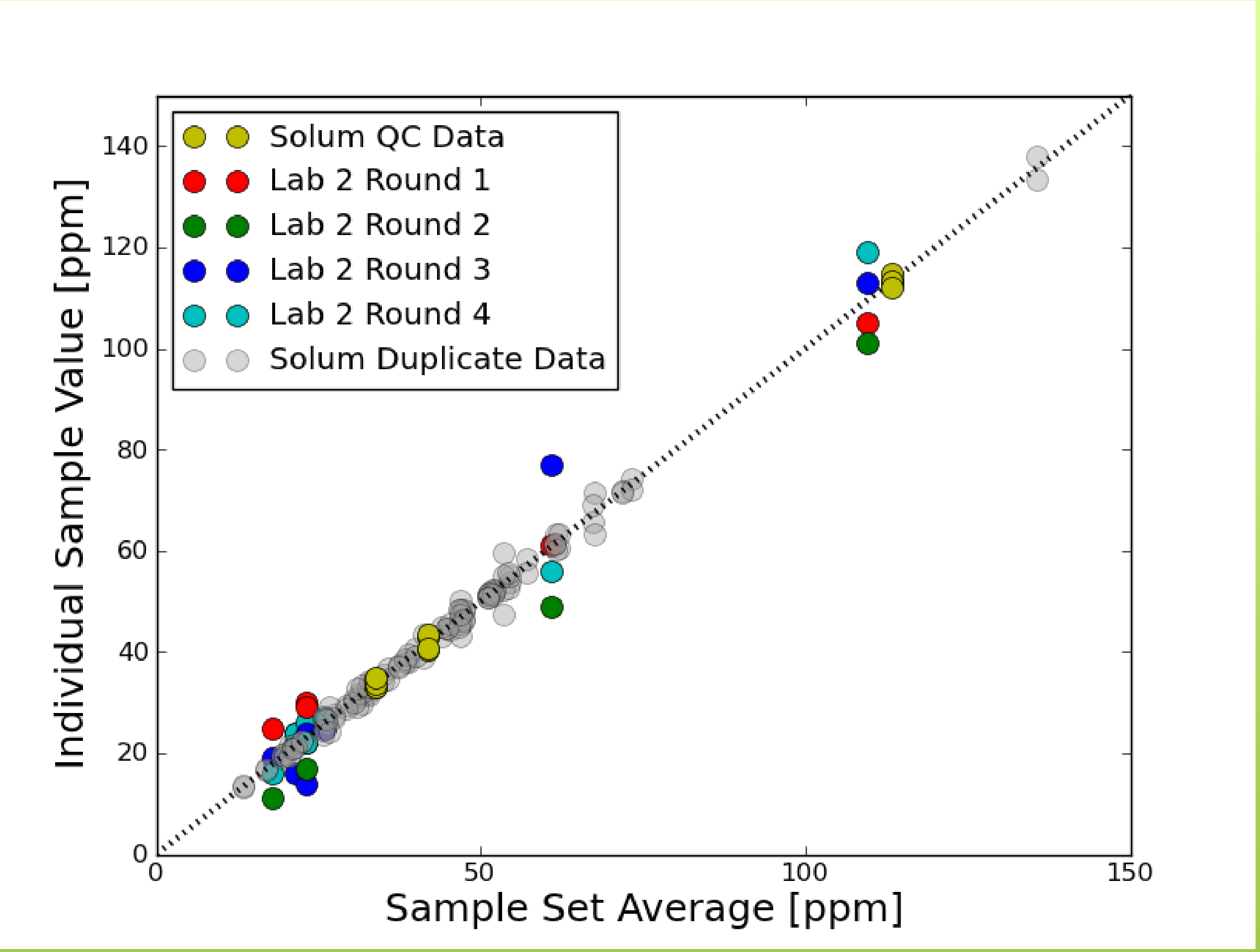
The value of a better process…



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3. **In-season measurements for nitrogen management**

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Nitrogen Management: Tools, technology, and measurements

- Critical for sustaining yields
- Big input cost
- Weather, field conditions affect management
- Increasing regulatory pressure

Nitrogen is the most critical crop nutrient, yet the most difficult to manage, due to its temporal variability

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Increasing threat of regulation…

In 2010, 68% of Corn Belt acres did not meet the criteria for efficient application of nitrogen rate, timing or method. (*USDA Economic Research Service)*

But there have been advances in hardware for N-management:

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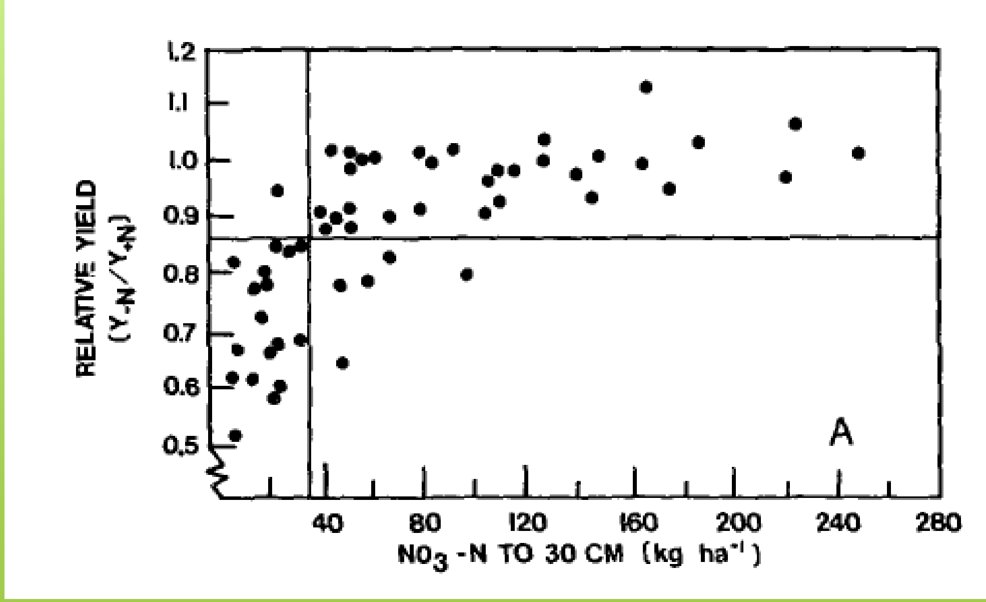
How can we use better data for better N-management?

In-season application (side-dressing) informed by in-season measurements:



In-season management informed by a PSNT is a widely accepted best management practice, but has proven to be logistically challenging.

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Magdoff et al, 1984.

Immediate, in-field nitrate measurements:

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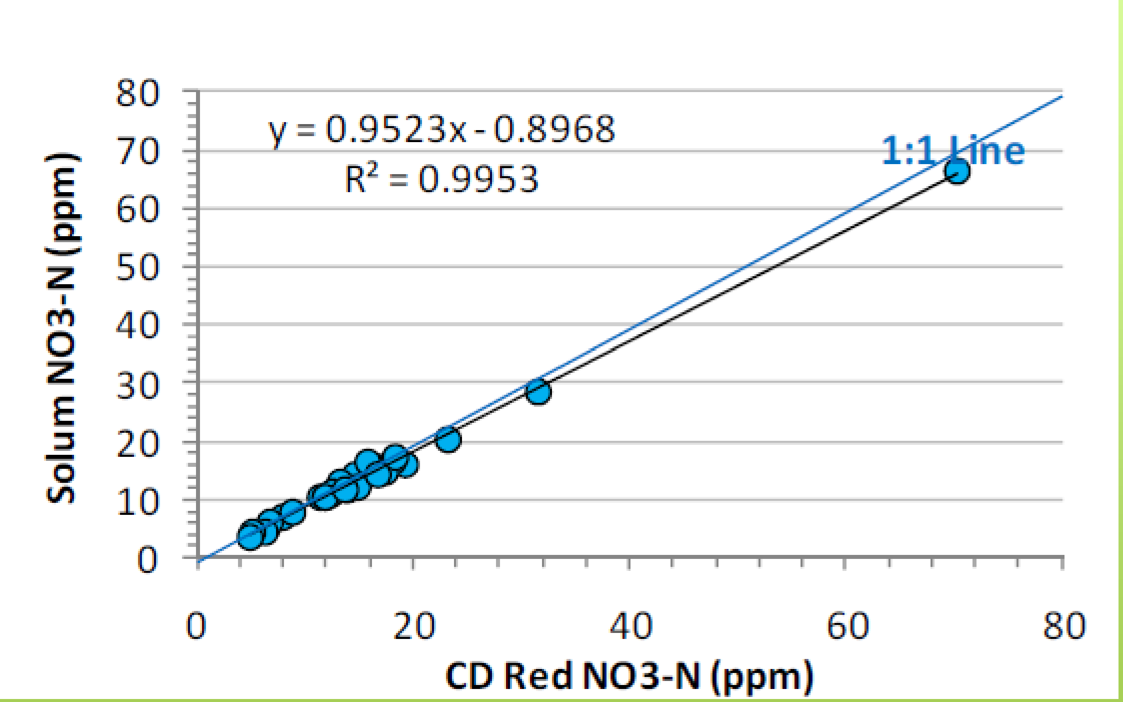
Immediate, in-field nitrate measurements:



Laboratory accurate measurements of NO3 in minutes.

- Determining optimal application rates
- Controlling input costs
- Achieving maximum yield

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http://solum.ag/briefs/Methods.pdf

Solum Agronomy Board:

Dean Fairchild:	Mosaic
Mark Alley:	Virginia Tech (Emeritus)
Randy Brown:	Winfield Solutions
Dan Schaefer:	Illinois CBMP
Scott Murrell:	IPNI

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Summary

Due to high input costs and high commodity prices, the price of getting nutrient management wrong has never been higher..

In addition to advances in equipment, seed and chemicals, new measurements are available to enable better management, particularly potassium and nitrogen.

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Thanks for your time!
Questions?

www.solum.ag

preiner@solum.ag

Appendix

Fall 2011 Field Trial Results

Phosphorus: *little or no* change observed with drying/grinding

Potassium: *significant* field dependent increase of K with drying and grinding observed; matches Antonio Mallarino's results.

Sulfur: *significant* field dependent increase of S with drying and grinding observed.

Zinc: *small* field dependent increase of Zn with drying and grinding observed.

pH: 1:2 dilution has slightly more error than 1:1 dilution. Using 1:1 dilution for Spring 2012; DG and FM match very well.

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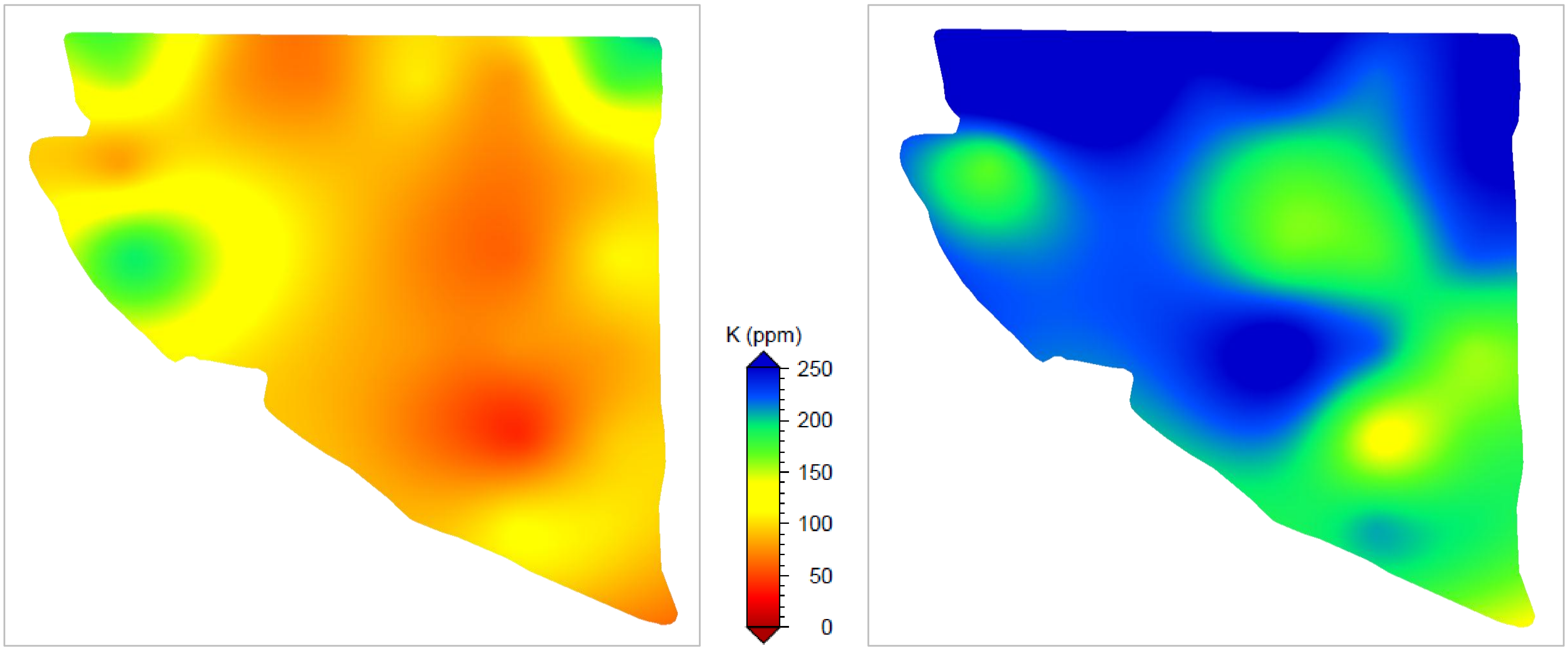
Method Comparison; Same Field Samples

Fall Field Trail Research, 2.5 A/G, Southeast Iowa, Fall 2011

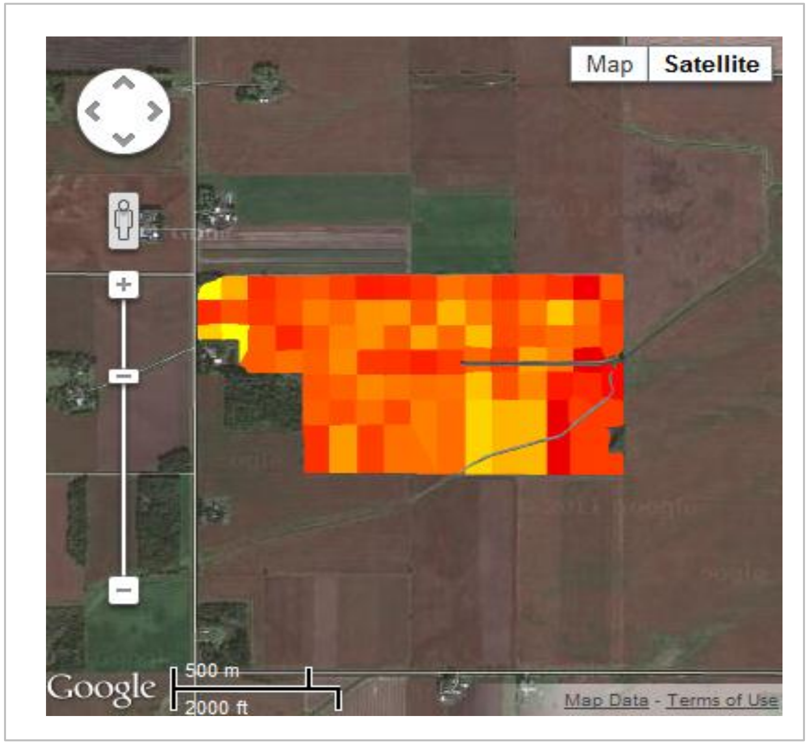


STK ANALYSIS RESULTS FIELD MOIST

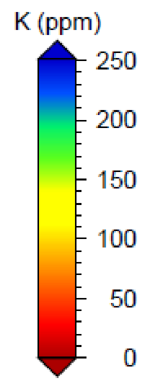
STK ANALYSIS RESULTS DRIED GROUND

Method Comparison; Same Field Samples

Fall Field Trail Research, 2.5 A/G, Southern Minnesota, Fall 2011



STK ANALYSIS RESULTS FIELD MOIST



STK ANALYSIS RESULTS DRIED GROUND

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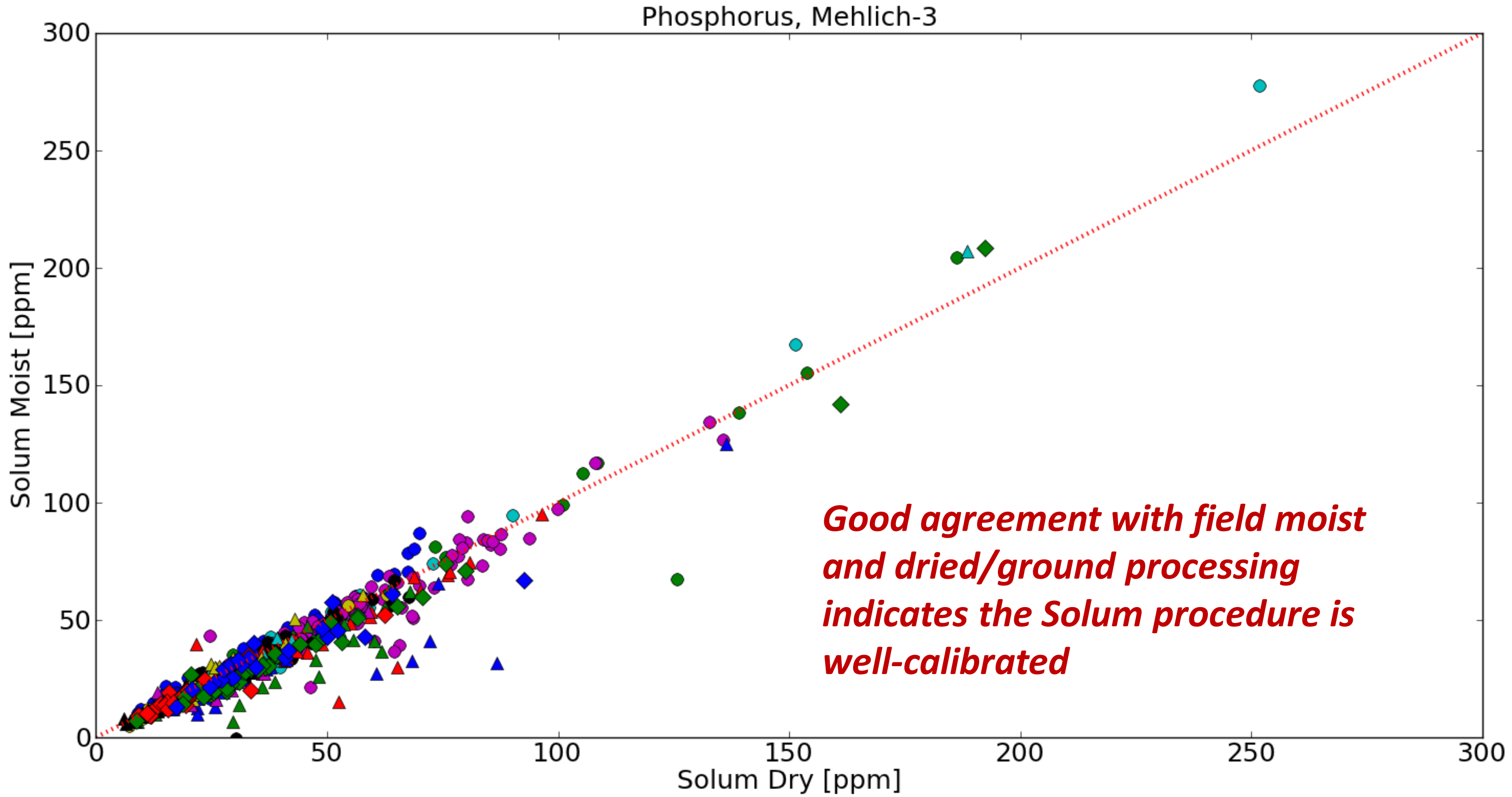

SOLUM AGGREGATE SAMPLE RESULTS

Phosphorus

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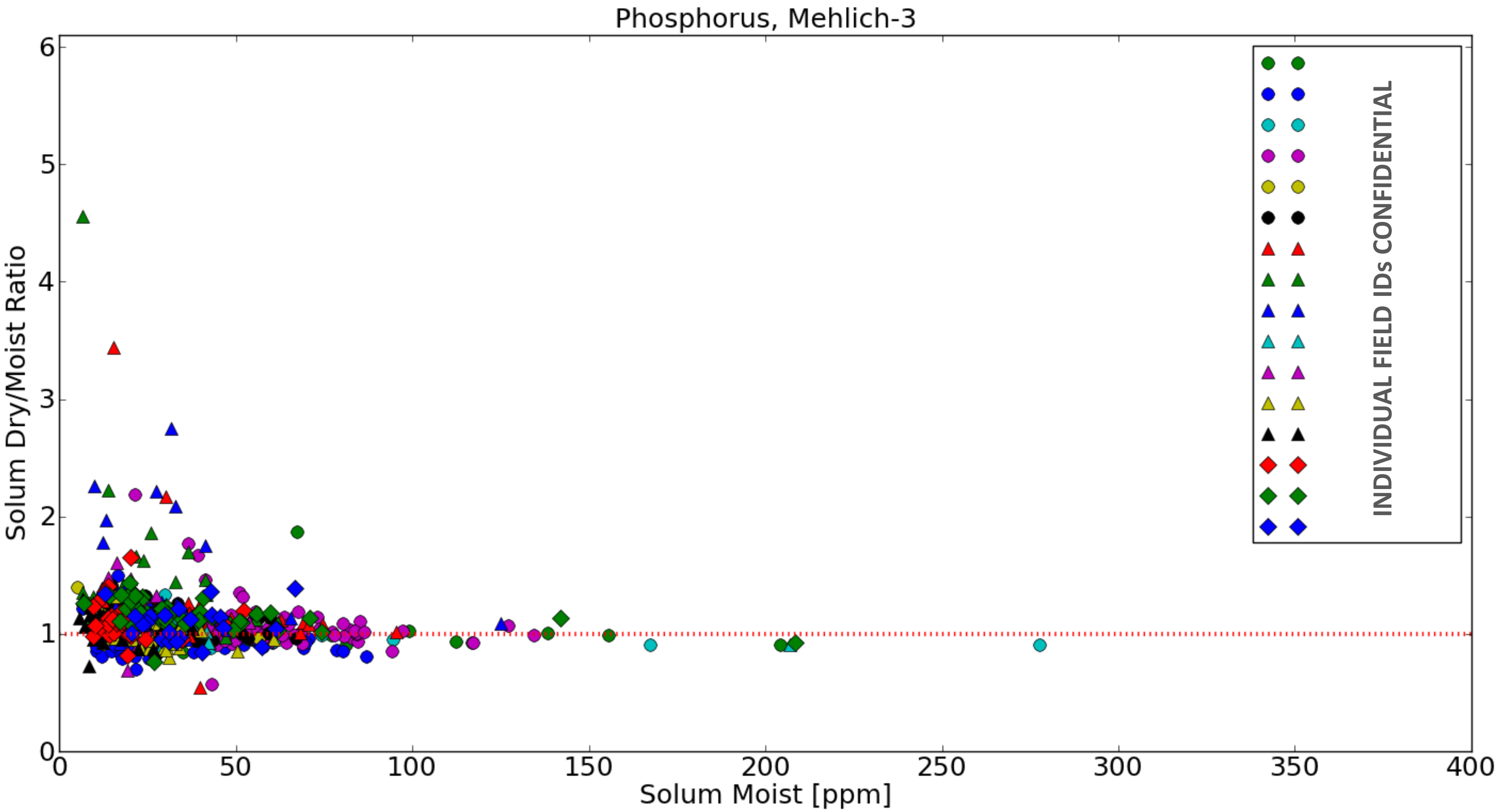
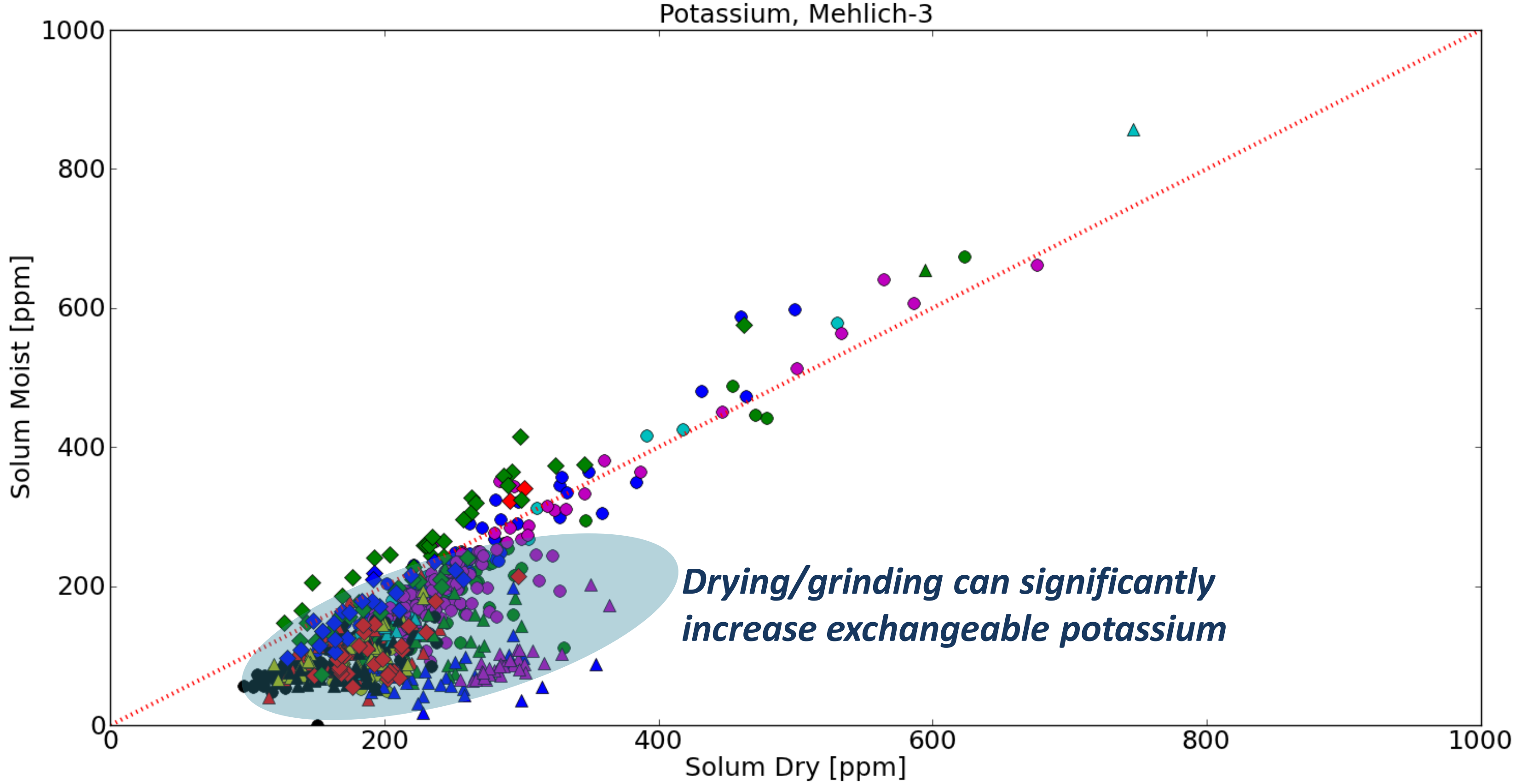


SOLUM AGGREGATE SAMPLE RESULTS

Phosphorus



SOLUM AGGREGATE SAMPLE RESULTS

Potassium

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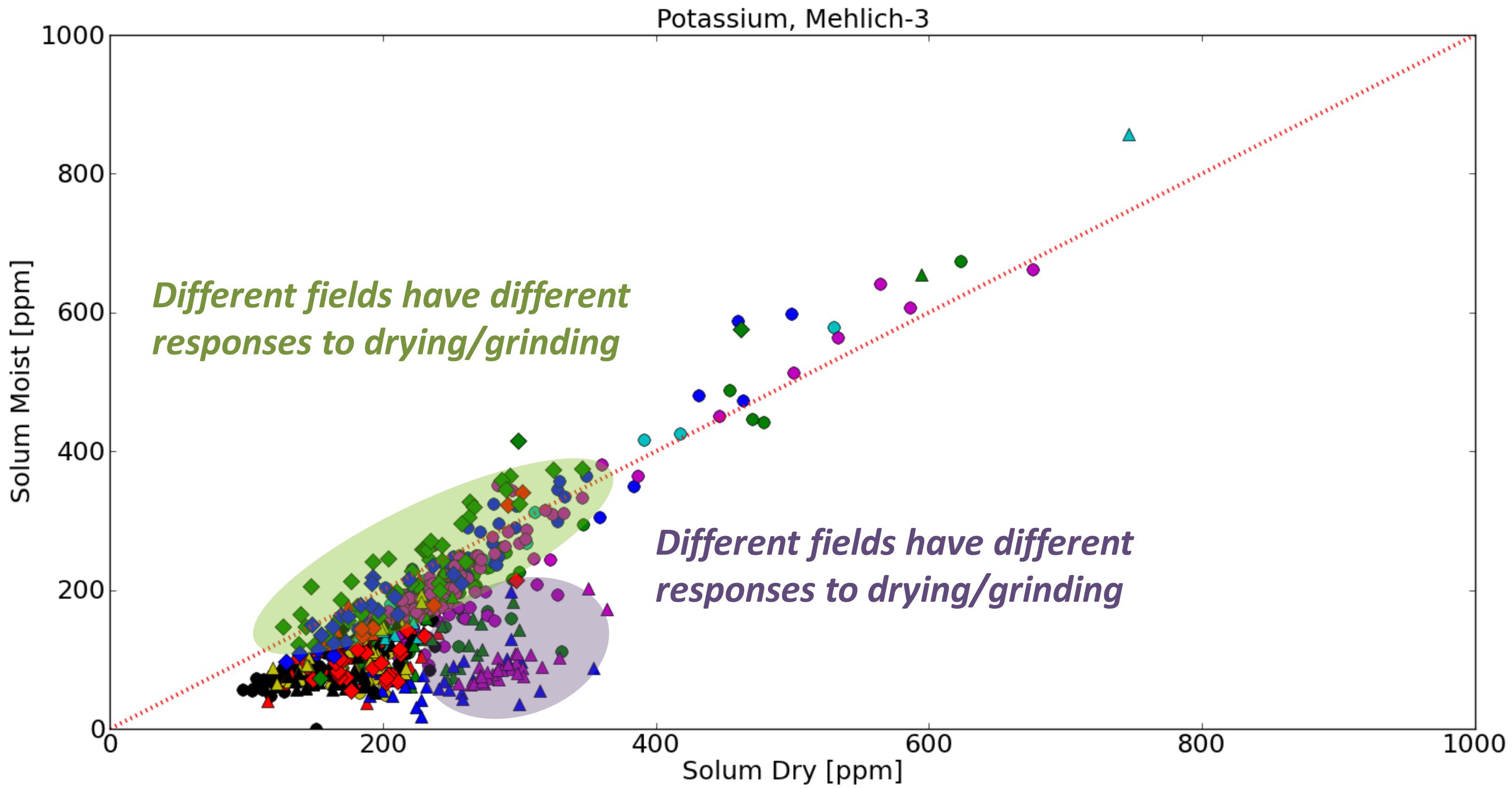

SOLUM AGGREGATE SAMPLE RESULTS
Potassium

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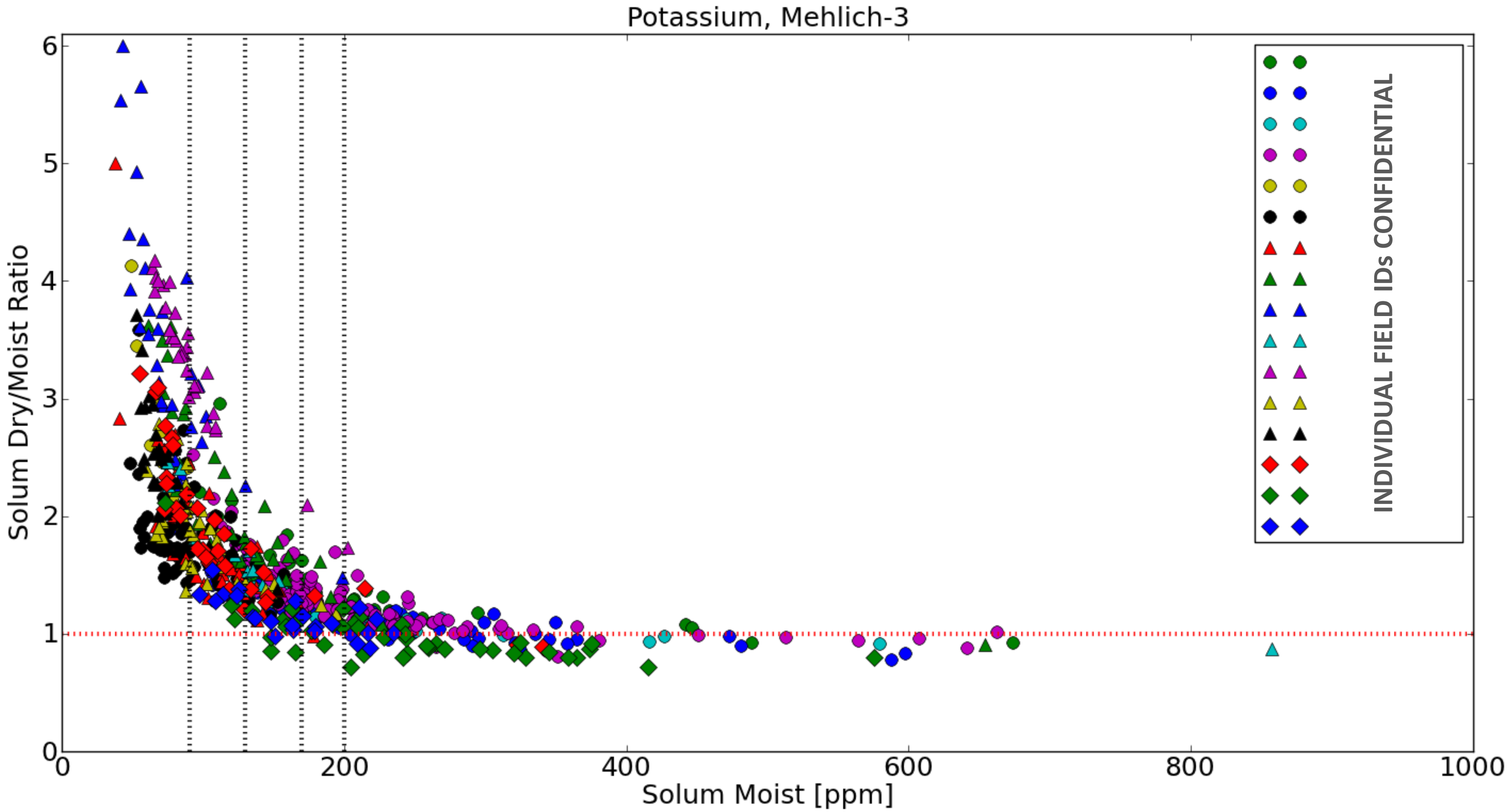

SOLUM AGGREGATE SAMPLE RESULTS

Potassium

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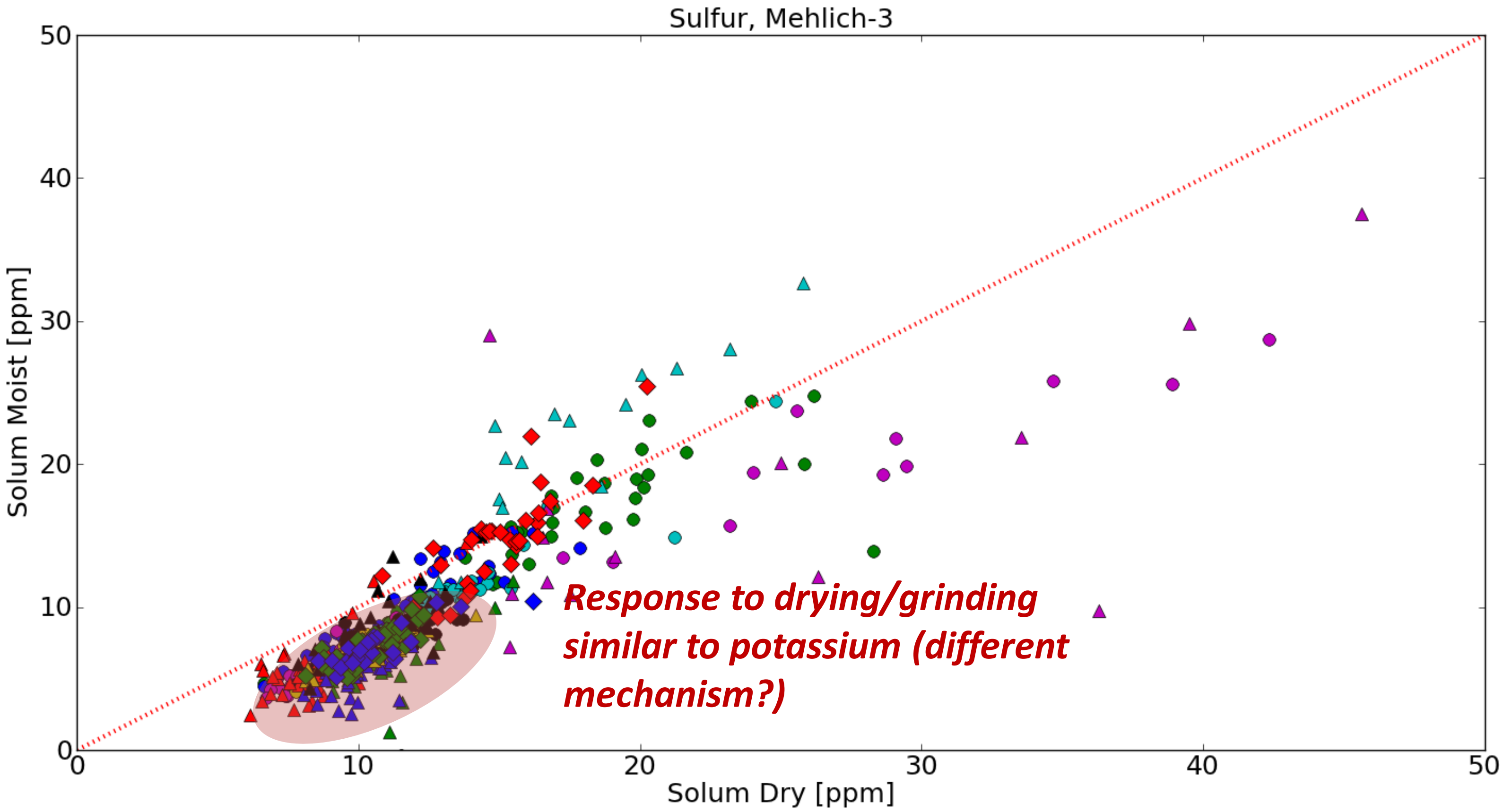

SOLUM AGGREGATE SAMPLE RESULTS

Sulfur

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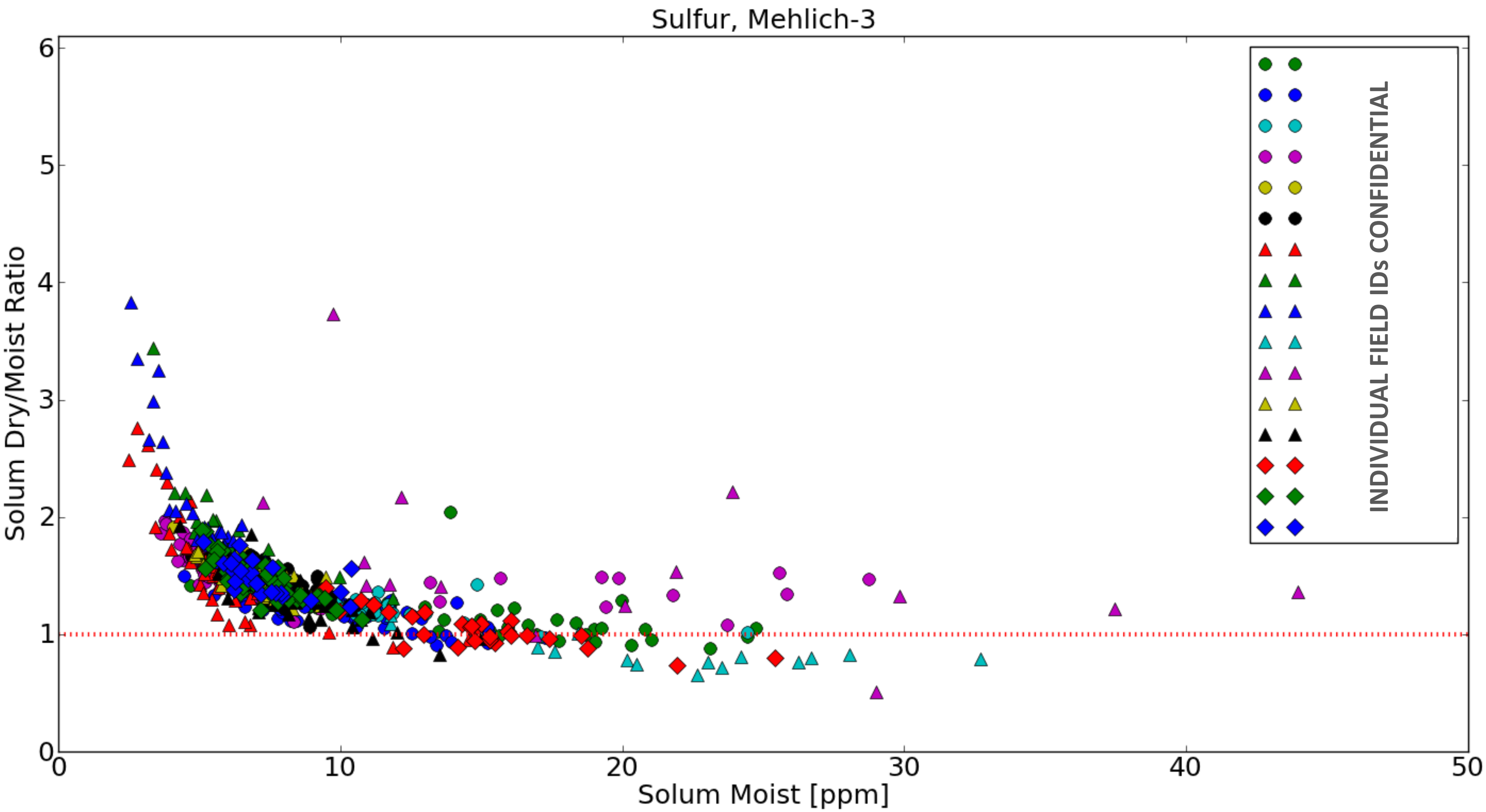

SOLUM AGGREGATE SAMPLE RESULTS

Potassium

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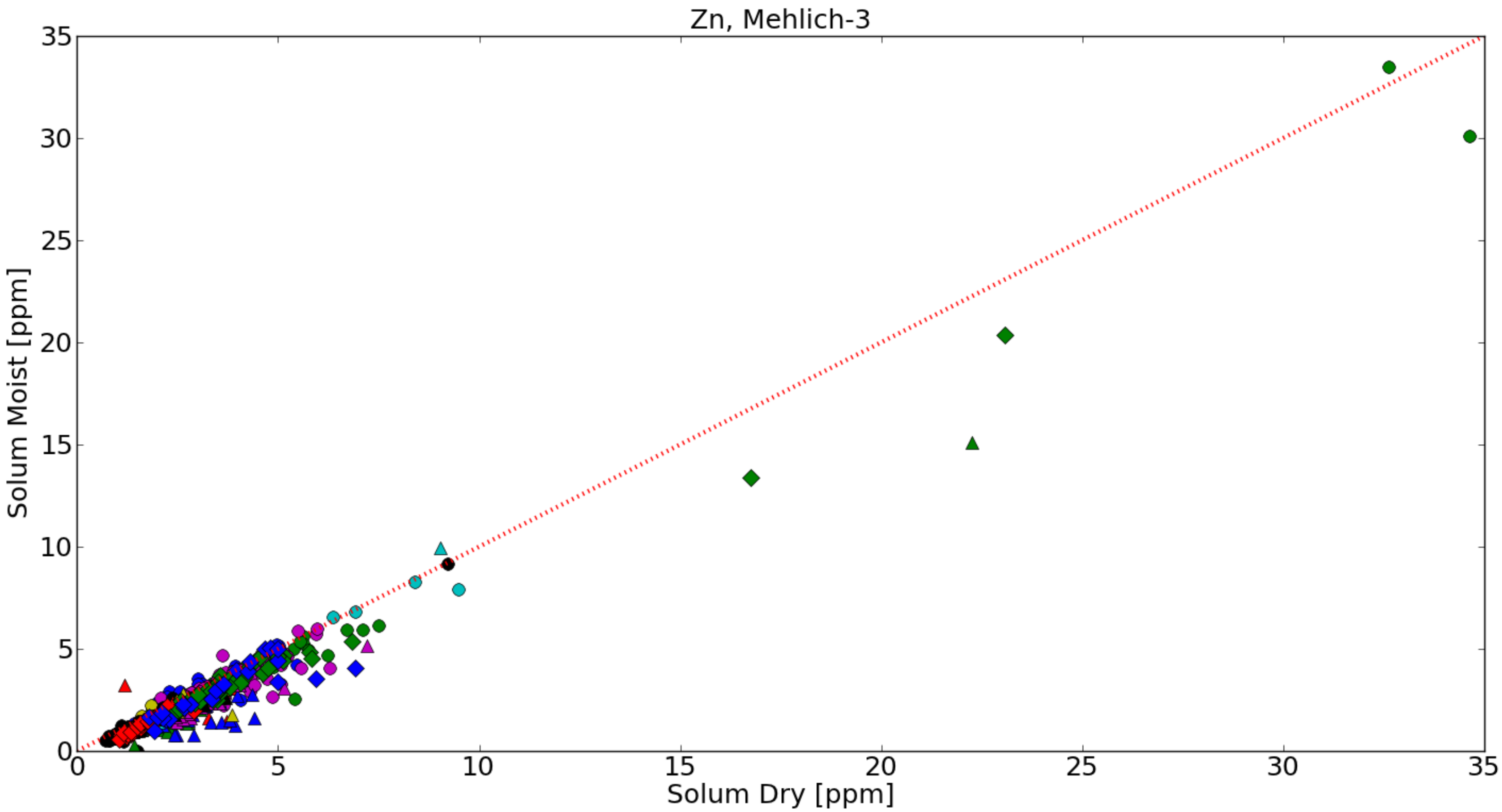

SOLUM AGGREGATE SAMPLE RESULTS

Zinc

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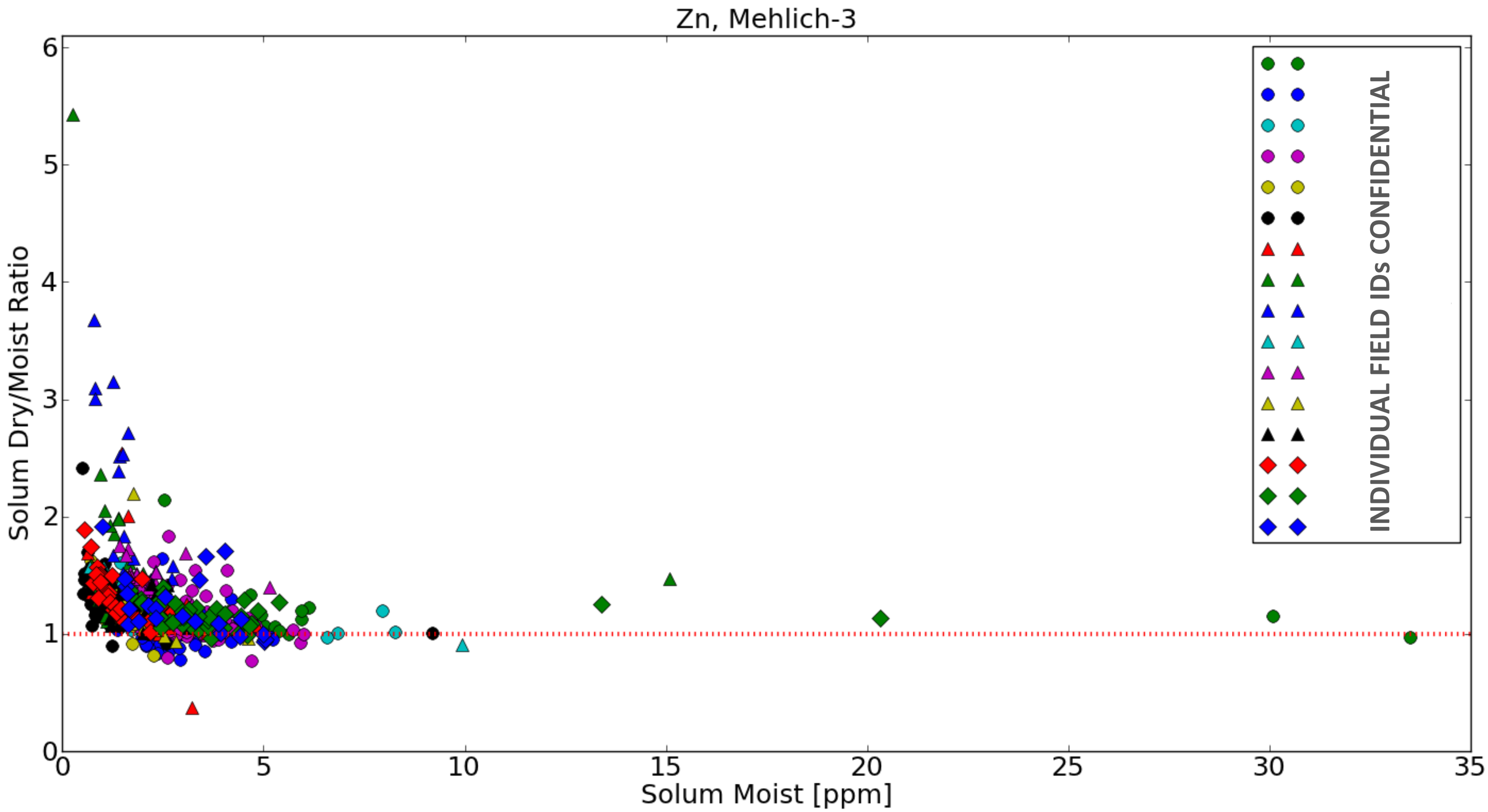
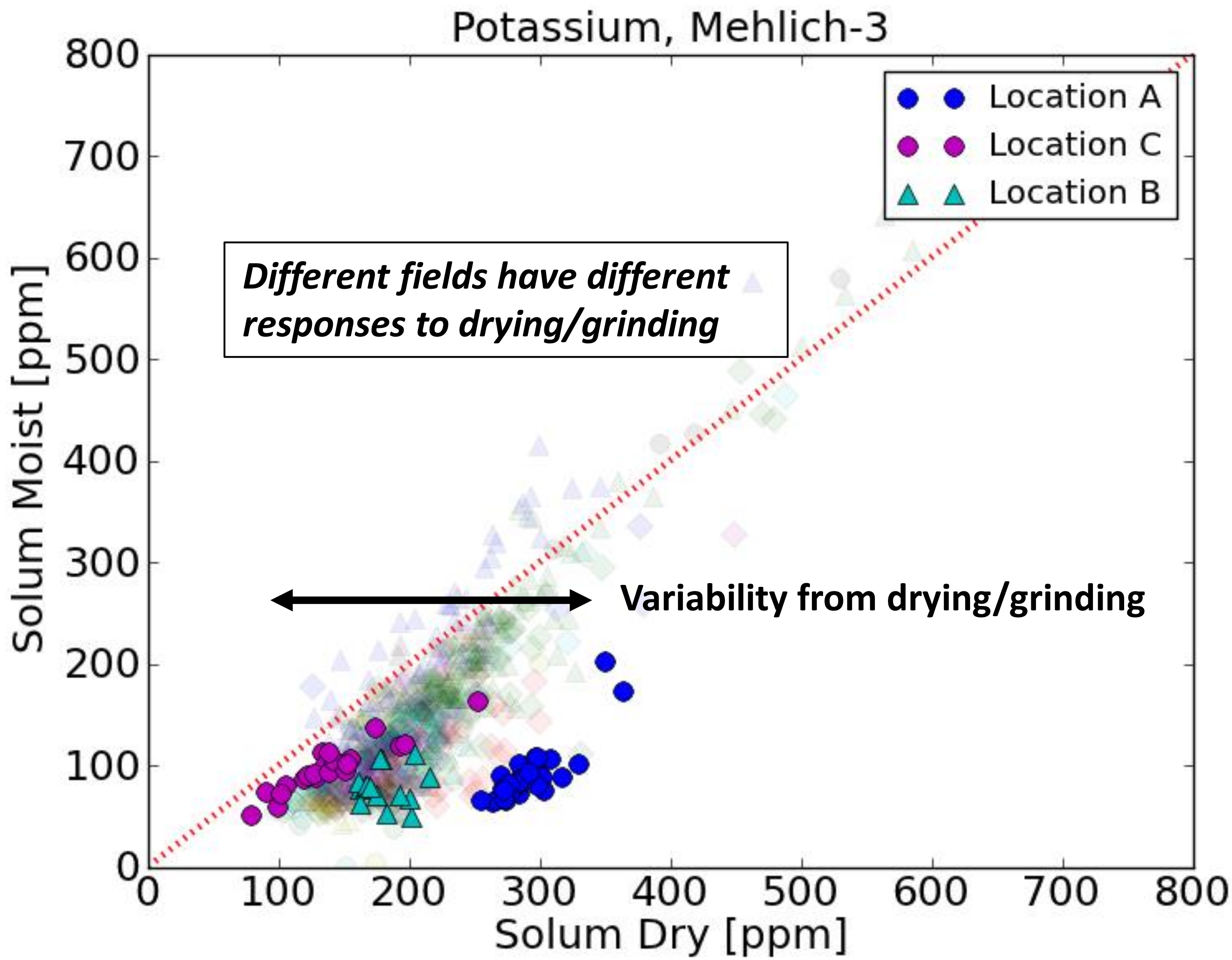


SOLUM AGGREGATE SAMPLE RESULTS

Zinc

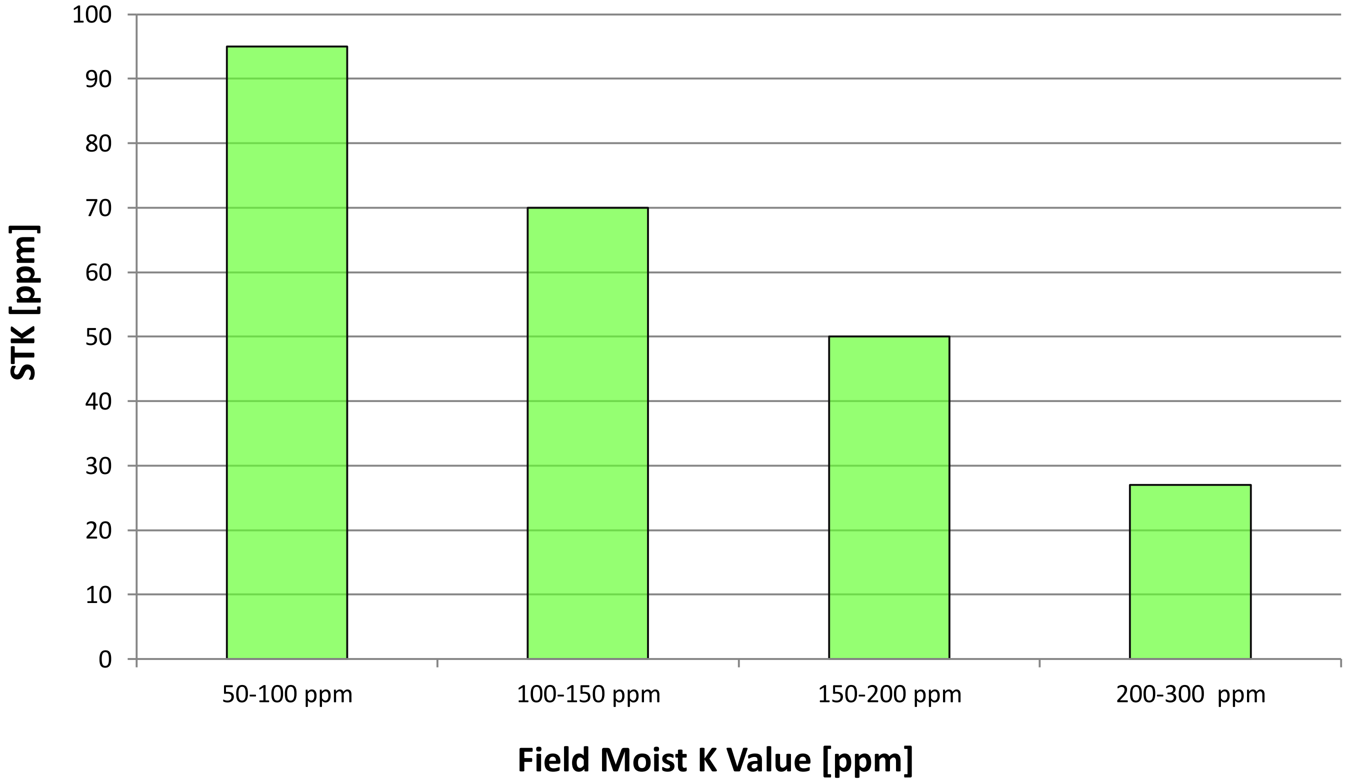
SOLUM



SOLUM AGGREGATE SAMPLE RESULTS

Potassium

Field Trials: Average STK Increase from Drying



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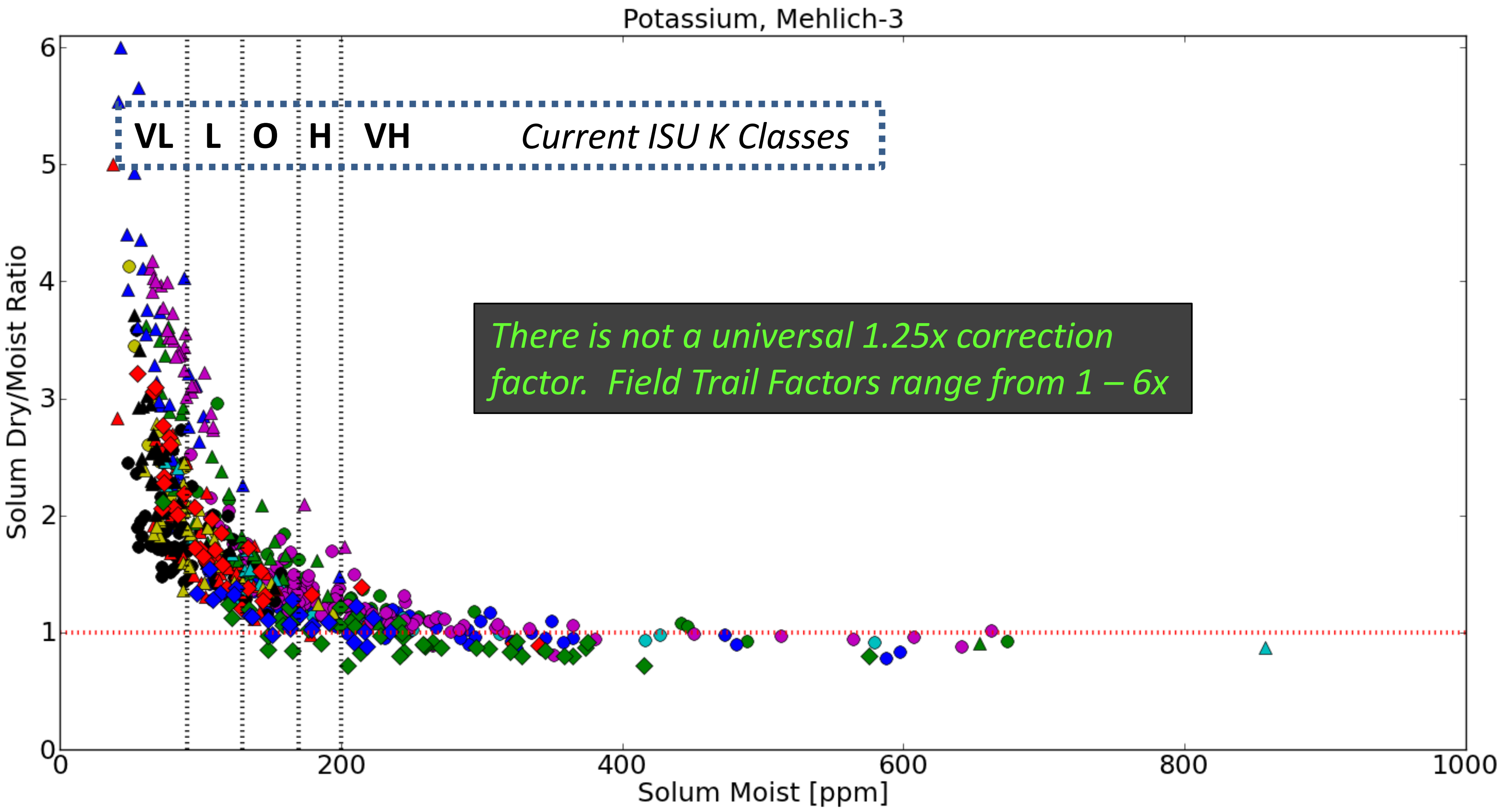
Potassium, Mehlich-3
VL L O H VH Current ISU K Classes
There is not a universal 1.25x correction factor. Field Trail Factors range from 1 – 6x
Solum Dry/Moist Ratio
Solum Moist [ppm]
0
1
2
3
4
5
6
0
200
400
600
800
1000

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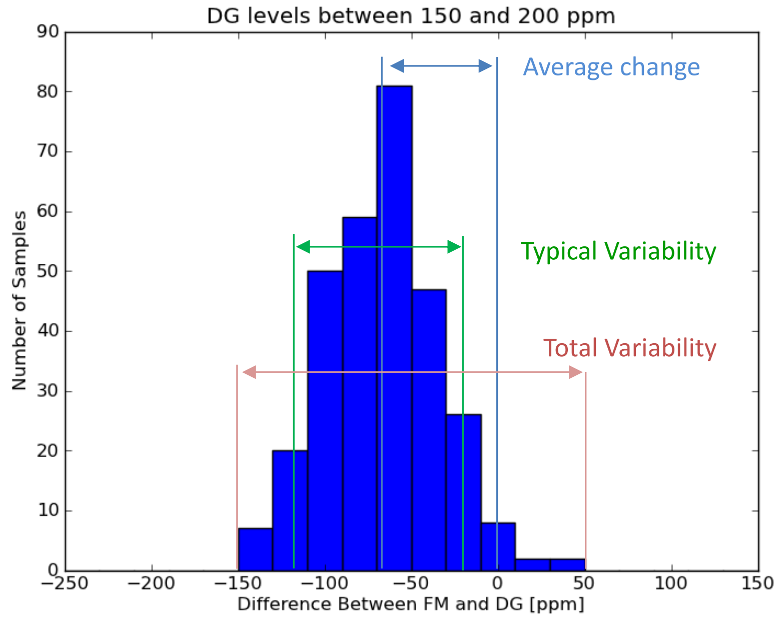
Field Moist/Dried Ground Interpretation

Dried/Ground STK (ppm)	0-100 ppm	101-150 ppm	151-200 ppm	201-300 ppm	301-400 ppm	401-800 ppm
Typical Variability Introduced by Drying/Grinding	15 ppm*	30 ppm	45 ppm	70 ppm	190 ppm	75 ppm
Total Variability Introduced by Drying/Grinding	35ppm*	200 ppm	200 ppm	380 ppm	350 ppm	250 ppm
Average Increase from Drying/Grinding	30 ppm*	50 ppm	65 ppm	75 ppm	80 ppm	-30 ppm

***In this data range 2011 field trial sample size is limited**



There is no simple conversion from field moist to dried ground.

Dried/ground levels are "typically" 30-80 ppm higher for relevant soil fertility levels, but this varies enormously from field to field.


advanced soils R&D
Laser Diffraction & True Texture Soil Analysis

Engineering Standards for Soil Texture

ASTM D 422: Standard Test Method for Particle-Size Analysis of Soils

This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process, using a hydrometer to secure the necessary data.

ASTM D 6913 (formerly part of ASTM D 422): Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

Soils consist of particles with various shapes and sizes. This test method is used to separate particles into size ranges and to determine quantitatively the mass of particles in each range. These data are combined to determine the particle-size distribution (gradation). This test method uses a square opening sieve criterion in determining the gradation of soil between the 3-in. (75-mm) and No. 200 (75-µm) sieves.

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Our Industry's Traditional Approach

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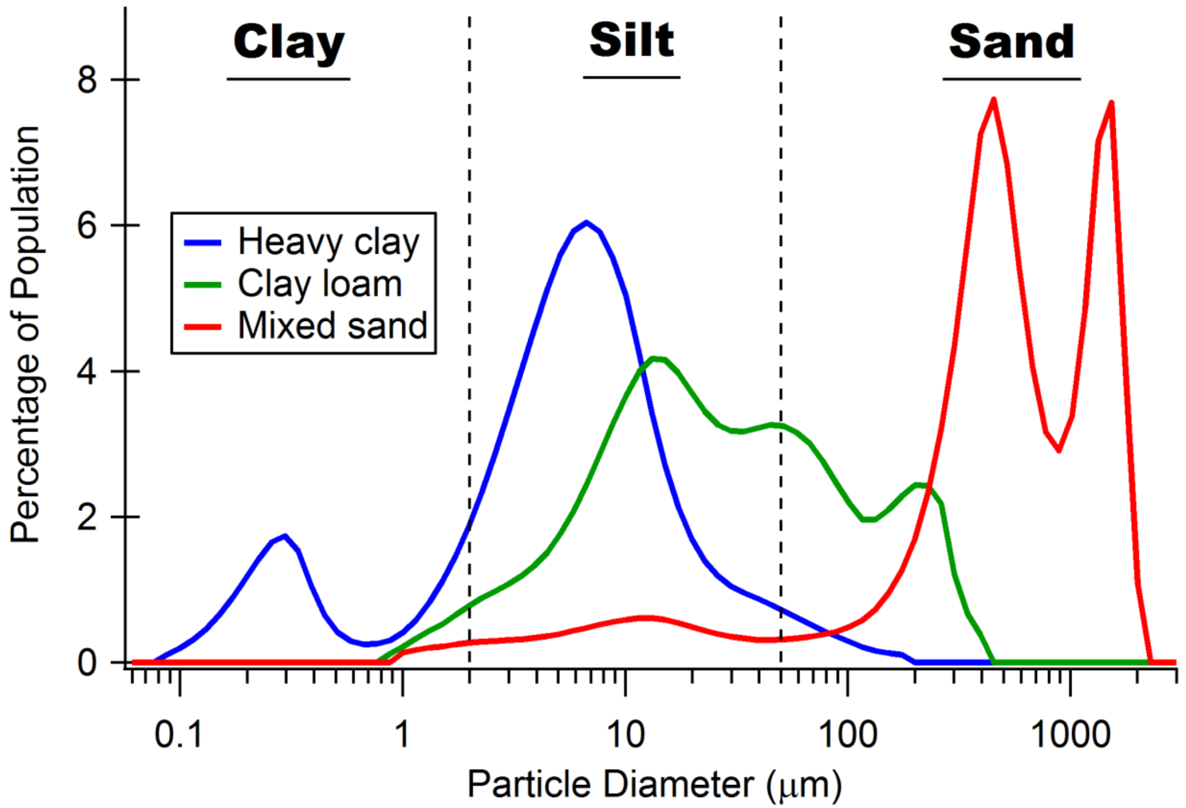
True Texture Analysis: Laser Diffraction



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